10am 3

PHYS-309 (3) Introduction to Modern Physics (48499-Kaldon)

Western Michigan University

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Class: MTu ThF 10:00-10:50am 1110 Rood Hall
Office Hours: MTuWThF @ Noon, MTuThF@1pm, MTuTh @ 2pm –
or stop in or by appointment.

http://homepages.wmich.edu/~kaldon/classes/ph309-3.htm

PHYS-310 (Laboratory) is a separate course.
You must be registered for PHYS-310 to take the lab.
Labs start the second week of class (Tuesday 13 January 2004); check outside lab door.

Required Texts and Supplies:

Modern Physics for Scientists and Engineers (2nd edition) / Taylor, Zafirators and Dubson *(henceforth TZD)*
Standard inexpensive calculator with trig functions and logs. ***NO TI-92/89 MACHINES!***

Optional:

You may find a book of integral tables useful; Standard Math Tables / CRC Press is recommended as a good all-around desk reference tool.

Optional Materials:

None, really. Study guides from Schaum's, or possibly even the textbook company, are available (or can be ordered) from the bookstore. These may be helpful for some people, but are not required and have not been used in the preparation of this course. There are also study software packages for Physics, but I haven't seen one that looked worth the money; so you might as well work the assigned Homework!

Significant Dates:

Jan. 6 Tue - PHYS-309 Begins
Jan. 9 Fri - Drop/Add Ends (100% Refund)
Jan. 19 Mon - WMU Dr. Martin Luther King, Jr. Activities < No Classes >
Jan. 29 Thu - Hour Exam 1
Feb. 24 Tue - Hour Exam 2
Feb. 27 Fri - Last Day to Drop without "W"
Feb. 27 Fri - Spirit Day <No Classes> , Semester Recess begins
Mar. 8 Mon - Classes Resume
Mar. 22-26 - March Meeting of the American Physical Society, Montréal QE
- Schedule Adjustments To Be Determined Later
Mar. 25 Thu - Topic 1 (Book Report) (due by 5pm Friday)
Mar. 29 Mon - Grace Period for Topic 1 ends at 5pm

Mar. 30 Tue - Hour Exam 3
Apr. 9 Fri - Good Friday (not a WMU holiday)
Apr. 11 Sun - Easter <<< Please Note Regarding Any Travel Plans + Classes
Apr. 16 Fri - Last Regular Day of Class
Apr. 22 Thu - Final Exam 10:15am-12:15pm (2 hours)
Apr. 23 Fri - End of Winter Session; Good Friday (not a WMU holiday)
Apr. 27 Tue - Grades Due at Noon
"All Exam dates are fixed in stone." See Dr. Phil otherwise.

Course Descriptions from the WMU Undergraduate Catalog via Registrar's Web Site
(http://sims.wmich.edu)

PHYS 309 Introductory Modern Physics
3 hrs. Fall, Spring
This course, with PHYS 205/206 and PHYS 207/208, completes the sequence making up the introductory courses in physics with calculus. Topics include special relativity, quantum physics, and atomic, nuclear, and solid state physics. This course consists of three lectures per week. Prerequisite: PHYS 207 and MATH-272 or MATH-230.

PHYS 310 Introductory Modern Physics Lab
1 hr. Fall, Spring
A laboratory course which includes exercises related to the topics covered in PHYS 309. Corequisite: PHYS 309.

Grading Scheme:

	A	AB	B	BC	C	CD	D	E
%-age	100-95	94-90	89-85	84-80	79-75	74-70	69-65	64-0

Raw exam scores may be curved.

The Million Point Grading Scale:

Quizzes	(10)	200,000 points	12 given; 2 dropped
H.W. Presentations		50,000 points	Every Friday
Paper		100,000 points	
PC Projects		150,000 points	
Exams	(3)	300,000 points	
Final	(1)	200,000 points	

1,000,000 points

Homework: Homework will be assigned for each chapter from the problems in TZD and other sources. Homework will not be collected, *per se*, but each student will be called to the board to present particular homework problems to the class. If you are not prepared to present, you'll come on up anyway and the class will work out the problem. Perhaps this will encourage everyone to *volunteer* to do problems when it is time to work on homework. H.W. points will be split between Preparation, Problem, Presentation and Participation in class. (And you have yet-another-reason to come to class on Fridays!)

Work To Hand In: All work that is to be handed in (which includes Quizzes, Exams, Papers, Special Topics) must include your name (you'd think that would be obvious, but…). – PAPERS WITHOUT NAME MAY NOT BE GRADED! **Staples:** Any papers turned in that are supposed to be stapled, but aren't, are

subject to a 3000 point penalty. Any papers turned in with a *fold-and-tear* corner will get an automatic 5000 point penalty. **Late Papers:** lose 10% (one letter grade) per day, but it is better *to do the work at all* than turn in nothing.

Writing Assignments: There will be one outside reading and writing assignments: a review article on a book from a booklist that will be provided in the first week. The paper is due Thursday March 25th by 5pm. There will be a penalty for each day a paper is late. Handouts are forthcoming.

Computational Physics Assignments: In addition to traditional pencil & paper H.W. we will take advantage of the incredible computing capability that is routinely available on PC's everywhere. Dr. Phil has some samples programs from various sources, and… we will delve into a little *real* computational solid-state physics, and use an actual copy of Dr. Phil's research codes to give you a taste of what real researchers do. Who knows how it'll all work – but we'll have fun. You will need the use of a Windows 95/98/ME/NT/2000/XP Pentium class (75MHz or higher) PC for Dr. Phil's codes.

Quiz Schedule: Each week there will be a quiz sheet. Some may be done in class, some may be take-home. Quiz problems will be based on the assigned homework and our current material. UNITS, SIGN, POWER OF TEN and VALUE of your ANSWER will all be evaluated on numerical problems. Reasonable units (I shouldn't have to spend time figuring them out) and significant figures are required. You must CIRCLE your ANSWER. WORK must be shown to receive credit, though the work itself may not be evaluated. There will be 12 twenty thousand point quiz problems. The lowest two PROBLEMS will be dropped. There will be no further adjustment of quiz grades. Quizzes may sometimes be graded on an "all-or-nothing" basis and cannot be made up, though up to two zeroes can be dropped as your lowest two problems.

Exam Schedule: There will be three "hour" exams, scheduled for: **Thursday 29 January, Tuesday 24 February and Tuesday 30 March 2004. Exams are planned for the whole class period.** Each exam will cover about three weeks of material. These exams will be closed-book, but you will be allowed to bring a **FORMULA CARD**. On this card, no larger than 5"x7" (127mm x178mm), you may write down any formula, physical constant, definition or a brief note on any historical figure that you feel is relevant or useful; short examples are allowed but *you may not include worked out problems*. Formula cards will be turned in with the exam, with a deduction for an illegal formula card. Each exam is worth 100,000 points. Scores may be adjusted on a curve to meet the Grading Scheme noted above. Exam questions will vary, but will include some complex problems that will test your understanding of and ability to apply the material. You may be surprised to hear this, but I do not expect you to be able to do 100% of the exam; in all likelihood, you've probably never taken exams like this before. They won't really get any easier, but you will get used to them. The Final Exam will **Thursday 22 April 2004 from 10:15am-12:15pm,** with a REVIEW during class on Friday, April 16th. The Final is worth 200,000 points. It is cumulative and you can use your previous formula cards. It may emphasize concepts and relationships over number crunching. If a curve is used on any exam, it will only bring grades up.

The Professional Concerns Committee of the Faculty Senate recommends that all faculty include the following paragraph in each syllabus that they prepare for the upcoming semester:

"You (the student) are responsible for making yourself aware of and understanding the policies and procedures in the Undergraduate (pp. 271-272) [Graduate (pp. 24-26)] Catalog that pertain to Academic Integrity. These policies include cheating, fabrication, falsification and forgery, multiple submission, plagiarism, complicity and computer misuse. If there is reason to believe you have been involved in academic dishonesty, you will be referred to the Office of Student Judicial Affairs. You will be given the opportunity to review the charge(s). If you believe you are not responsible, you will have the opportunity for a hearing. You should consult with me if you are uncertain about an issue of academic honesty prior to the submission of an assignment or test."

Sorta Important Stuff

(This Section Was Originally For the First Year Course, But It Still Applies to the 3rd Semester)

The First Thing You Should Do Each Day When You Come Into Class…

(after getting comfortable and pulling out your notebook and pencil)

…Is To Take OUT Your Calculator And Have It Ready At All Times

(it doesn't do you any good all closed up in your book bag, or at home)

Grading:

The process and the concepts are so important, that getting the correct numerical answer is sometimes the least important part of a calculation. Therefore, there will be some partial credit on some exam problems for taking the correct line of reasoning, even if the answer is wrong. This does not excuse you from taking reasonable care in a calculation. (Grading this way is very labor intensive, but your patience will be rewarded.)

Units, Numbers and other parts

For a business that relies so heavily on numbers, it is very rare that the answer to a Physics problem is just a number, like "five". "Five what?" is usually a reasonable question, so units are a very important part of a number. Indeed, if you keep units with their respective numbers, units can be used to save your life in a problem. If you are expecting a velocity and get an answer that isn't in units of a velocity, then it may be possible to find your mistake.

So many errors in Physics problems can be traced back to the use of the wrong "thing" in a variable, sometimes to the point where even I can't figure out what you were doing, that we are going to be **very, very, very** hard on units this semester. So here's the new rule:

UNITS ARE TO BE CONSIDERED PERMANENTLY STAPLED TO A NUMBER.

Every time you write down a number, you write down the units as well. This means (a) when you write down the numbers in the beginning of the problem, (b) when you write down your answer and (c) *most importantly*, what Dr. Phil calls *Internal Units* – that means when you are writing down a number in an algebraic expression before you haul out your calculator. There will be no alternative here, because otherwise you won't be scoring any points here on quizzes and exams. You'll notice that Dr. Phil always includes units with his numbers on the blackboard – take that as a hint.

Likewise, the sign of an answer can be very important in some problems. Your bank has no trouble with telling the difference between having a **$500** checking account balance and being overdrawn with a **-$500** balance, for example; these are very different answers. One must also watch out for powers of 10, since the metric system is based on a decimal system, just like the American money system. A kilometer is a kilo-meter or 1000 meters. Another number problem: 4.97 is a number that is about five, but 4.97 is not the same as 5.00 . Again, your own background with money can help you. Your calculator is not very intelligent, so you must determine which numbers in the display represent significant figures, based on the actual numbers you used as input to your calculations. This is particularly important in lab; in lecture and discussion, you will find that we tend to use "reasonable" numbers in answers. I cannot guarantee that you will get exactly the same answer as I do, since the order you do math operations and the brand of calculator can have some impact on the final result. As a general rule, do *not* truncate or round numbers too much in intermediate calculations or dump your entire calculator display into a final answer.

Also – we do not normally deal in fractions. 1 2/3 is 1.67 to three significant figures

Laboratory:

Lab is an integral part of any serious study of Physics. You may or may not be taking the lab course, PHYS-310, at this time. You will find that it operates very differently than in PHYS-206/208.

Make-Ups:

Quizzes cannot be made up. You are expected to attend classes anyway, but this is especially true of examinations. Provided you have a valid reason for missing class (illness, etc.), if you miss an exam, you must contact me as soon as possible to arrange an exam within a few days.

This is winter in Michigan – Land of Driving Adventures. Dr. Phil has a long commute (154 miles/day) and will make gallant efforts to be here on time every day – *but* ultimately all of us have to be intelligent enough to make decisions between *trying to get to class* and oh, say… *living*. Physics is important, but if you or your vehicle can't make it, then you can't make it.

Extra Credit:

I don't "do" extra credit. Students who wish extra credit primarily do so because they aren't using their time effectively already, so why would I wish you to divert even more of your valuable time on additional work?

Interesting (?) Thoughts

Natural Philosophy

Physics was once called Natural Philosophy in colleges and the term has some very good connotations. Physics is a study of Nature and how Nature operates. Physics is often a philosophical arena, where meaning and understanding are gleaned, debated and tested from observations of the real world, experiments in the laboratory, with theories and long "what-if?" and "what-about?" sessions. I often suggest to students that "We are here to change the way that you think" and this is borne out in the many students who comment at the end of the course that they do think about and see the world is a different way. Many tell of how sick to death their friends and family are to here them babble on about "this is how that works" or "don't you wonder why that happened?" Most people go through life not thinking those thoughts or asking those questions. (Or else believe that it must be too difficult for them to understand.)

What's Modern about Modern Physics?

The introductory Physics course that you have already taken in primarily a nineteenth century course, especially the mechanics course, with a bit of early twentieth century atomic and nuclear physics, depending on the course, text and instructor that you had. PHYS-309 is intended to help bridge the gap between the introductory course and a contemporary study of Physics.

Where'd All This Old Physics Come From?

Still, there are very good reasons that you needed to take that introductory Physics course, and as you'll quickly see, our first real class day is a crash review course. Nearly everything that you covered last year will be brought in for a brief reprise encore performance, if not a full blown revival.

The Circle of Physics

When I was a lad, science fiction stories were full of memory RNA pills that would teach you complicated subjects, or at least give you the neural connections to do the work until the pills ran out. Real Physics tends to be taught in a series of cycles. In the intro course you cover Mechanics, E&M, some Thermo, some Optics and maybe a little Special Relativity. In Modern Physics you learn more about Relativity, Quantum Mechanics, Solid State Physics, Nuclear and Particle Physics. If you continue on in Physics, you will take a course in Advanced Mechanics, Advanced E&M, and courses in Thermo, Quantum, Solid State and Nuclear Physics. In graduate school, one takes Graduate Mechanics, Graduate E&M, Graduate Quantum.... perhaps now you can see the trend. Along the way, one can build on the mathematics and physics foundations you've been building. The advanced Hamiltonian and Lagrangian solutions of QM and Mechanics are related to each other. If there were Physics pills, you could cut through the first couple of repeats in the cycle and get straight into the most interesting problems of the

day, the cutting edge as it were. But we have to do it the old fashioned way. Don't despair – there's plenty of fun and intriguing stuff to cover, and plenty of looks at that rough and raw leading edge.

Theory and Experiment

Sometimes it seems that Physicists get polarized into two camps, theorists and experimentalists, that are always at war with each other. In truth, we know what we know, because of the results of careful and repeatable experiment, tempered by a theoretical framework that allows us to make testable predictions. A lot of the leading edge stuff is done "without a net", in that sometimes the predictions are not yet testable, or the experiments are not yet reliable. That's why theory and experiment don't always agree, and why we go through rounds of revising theory.

The Correspondence Principle

There are also levels of theory and experiment. There are people who believe that since Einstein's relativity supersedes Newton's classical mechanics, that Newton is "wrong". At a certain level this is certainly true. But there is no point in trying to treat a '74 VW Beetle as a relativistic, quantum object, unless you have some really bizarre set of circumstances (such as launching the car at 70% the speed of light!) that really require it. The Correspondence Principle is the environment where Classical Physics and Modern Physics meet, where both methods give pretty much the same solution.

Occam's Razor

It is vain to ask Nature to do with more, that which can be done with less.
William of Occam (c.1285-1349)

William of Occam's statement is a favorite of mine. Engineers are sometimes taught this as the KISS principle (Keep It Simple, Stupid!). We don't go through all this rigmarole just to make more difficult problems. The beauty in Physics lies in the simplicity of the final statement. The Ancients believed in four elements: Earth, Air, Water, Fire. It was a good system for them. The Periodic Table could have been composed of elements that are all fundamentally different from each other. Imagine 110 or more completely different kinds of stuff. On the other hand, think of the intellectual leap of thinking to consider the possibility that all atoms are made of the same building blocks. That the Physics of the Periodic Table flows into the system that we call Chemistry (and back again), and we think we can make some real sense of it all is because we have a simple system. Sure, in reality it's complicated. But the basic design is simple. And the real value of keeping the Razor around, is that we see it in use in science all the time.

Things You Should Have Learned in the Introductory Course

Through all this we are assuming that you are familiar with the introductory General Physics course. Note that I said "familiar with the course" and not "familiar with the material". Having had a Physics course in the past, and it is likely that it has been several months to several years since you've had this material, I expect that it will come back to you fairly quickly, and that you should still have your General Physics textbook and the mental toolkit to reconstruct topics like conservation laws in collisions. Our *very* brief review of some of the Physics required in PHYS-309 is no substitute for checking out Serway, or Halliday, Resnick & Walker, or whatever your previous Physics textbook happened to be.

The Million Point Grading Scale

You may have noticed the outrageous number of points assigned to our workload. Over the years I have found that many people don't have a good feel for very large and very small numbers, things we will be using a lot in PHYS-309, so I created The Million Point Grading Scale as a kind of numerical literacy device. It breaks the usual mold of 100 point tests and eliminates haggling for points. Anyone who wants "a" point, can have one. You must complete all elements of the course in order to earn the rest of your points, however.

Bad Chapter Karma

From Chapter 1 to 18 in TZD is eighteen chapters. From January 6th to April 16th is *less* than fourteen weeks of classes. It shouldn't take advanced calculus to figure out that there is a mismatch here – that we can't quite manage only one chapter a week. On the other hand, we may adjust the topics list as we go, and we might drop some sections or chapters as we go along, or at the very least, touch on some topics without devoting critical exam and study time on them. Note the chapter lists that go with each exam.

Common Sense

It is an asset to make a guess about what is going to happen in a problem. However, you must watch out that you let the Physics do its work and not talk yourself into a mistaken notion. It is sometimes thought that good Physics thinking is just good Common Sense. All of us have some idea how at least part of the world works, but Common Sense doesn't always seem to be so Common among us, or so Sensible. Instead, we will work to a logical model of how things work, one that is independent of personal feeling (red cars don't really go faster than blue ones). This is not easily done, since most students don't get very much Physics education early on: a survey done a few years ago suggests that even students in graduate physics classes tend to write one thing on a test paper and believe in their "common sense experience" in everyday life. But don't despair - there are a lot of common sense experiences that do work in Physics under the appropriate conditions, such as "what goes up must come down."

Concepts

It is possible to teach an entire course in "Conceptual Physics", where one hardly ever sees a number or an equation. This isn't one of those courses, because the equations and the numbers have so much interesting meaning attached to them, that it would be a shame to leave them out. But it is very easy to lose sight of the Concepts amongst all the math. Short answer conceptual questions on exams should be almost "freebies", but usually aren't because the most basic definitions are forgotten in the cram for the details of specific cases. Learn the definitions and the general concepts, and the specific cases will take care of themselves.

Vocabulary

It is not surprising to think that a science such as Physics should have developed a vocabulary of its own. But Physics tries to be a precise description of the world and so therefore the meanings of many ordinary everyday words must take on a new precision of their own, too. We now know after a year of Physics that mass and weight are very different, even though they might seem to describe the same thing to the layperson. Or that work has a special definition, a precise meaning, that is understandable to physicists and physics students around the world. Indeed, the concept of doing "no work" in Physics is very different from the usage we have in everyday speech.

Equations

Physicists are capable of driving other people crazy, as we can happily work all day with equations without ever once feeling the need to plug in a number. The concepts and the theory frame the question and the answer, it is the equations that supply the tools for our solution. In reducing numbers down to letters, we are limited by the number of upper and lower case letters in the English and Greek alphabets. Therefore, what "**v**" might represent in any equation must not only be known, but "**v**" and "**V**" are also likely to be different from each other. And then there's the Greek letter "ν", or *nu*, which isn't the same thing at all. This is not a bulk memorization/ regurgitation course, so you will be allowed to bring your very own formula card to exams. It is up to *you* to keep track of which letters go with which physics.

Theory

The theories presented in this course have a long and colorful history that is interesting in its own right. Much like case law to the legal profession, current Physics theory has been "tried and proven" over the years. Unlike law, however, it isn't how slick or well-paid your physicist is versus mine, here the burden of proof falls on experimental verification. Even so, "proof" is too strong a word for some in science,

rather one might say that something is true within these limitations. The bulk of the material covered in PHYS-309 has been around for some 50 to 100 years. Unlike the General Physics I and II courses, which are primarily nineteenth century courses where the Physics doesn't change much, Modern Physics does have to update itself. Still, we will spend most of our time at least some distance from the bleeding edge of current Physics.

Comments and Hints

Chapters 1-18

It would be "nice" to run through the textbook from cover to cover, but often we fall behind or skip topics. So I've penciled in a schedule of chapters and topics on the last page of the Syllabus. This doesn't leave us room for getting behind. And it certainly doesn't leave us any room for getting to Chapter 18 late, which is where all the interesting trouble lies.

Time Management (Studying)

Since we have a lot of material to cover, and it is probable that you won't have time to work out ahead of time every Physics problem in the book, it becomes important to manage your study time wisely. **It is very common to end up spending hours banging your head against one stupid little problem.** Mostly this involves doing the same solution over and over again, or dragging in every conceivable (and inappropriate) formula under the sun. Most of the textbook problems have only one or two elements in them, so in general you may need to simplify your work, not make it overly complicated. If you are having trouble with a short problem, you are probably making them way too hard. Think basic definitions! If you find yourself spending long hours without getting any benefit, come and see me and we'll try to help. Very few students can ever get by without doing any work outside of class.

Time Management (Exams)

Staring at an exam page is not the time to learn how to do Physics. Good exam time management starts with being familiar with the homework problems, the basic concepts and the formulas on your formula card. Beyond that, you should remember that most parts of the test are equally important, so don't spend all your time on one problem or part. Go onto another problem that you can do. Don't worry about what other students are doing. The student who gets up and hands their paper in halfway through the hour has used up as much time as they care to (for good or bad); it should have no bearing on your test. Do look through the whole test when you get it, making sure that yours is complete. Do keep units with your numbers and check to make sure that (a) the numbers and (b) the units of your answers makes sense. Don't leave any parts blank if you can help it.

Still Having Problems?

Killer Equations

There is no one equation to "Life, The Universe and Everything". Every equation developed has some built-in limitations and some very real restrictions on when you can and can not use them. There are plenty of examples done in class and in the text which result in equations to solve a particular case. Students are inevitably tempted to use such "killer equations" for any problem that involves those quantities, because they thing that the work has been done for them. The range equation is a classic example in ballistics, but this equation cannot be used unless the launch points and landing points are at the same height. Despite that warning, freely given in class, the range equation will be used to find out how far away a arrow will land, even if the archer is standing on a hilltop. In most cases, you are better off using the more basic, more general, more useful equations than searching for that "killer equation" that will solve the problem with one plug-in. Somehow the latter hardly seems like the kind of examination that would prove that you had learned anything.

Graphing Calculators

Just in the years that I have been in school, I have seen the rise of the calculator, the disappearance of the slide rule, and a definite drop in the ability to do simple error-free mathematics. When I was in college, there were stories about MIT and Harvard being concerned over students "cheating" with programmable calculators. As a physics TA, I found students who used the old *TI-30-II*'s white face to pencil in all their formulas between the keys. Such cheating is not necessary, because I allow you a formula card up front. Today, the *Texas Instruments TI-80 series* graphing calculators are virtually standard issue in many college math and physics departments. Top flight calculators not only contain Physics, Math and Engineering equations built-in and powerful symbolic math programs that will handle fractions, algebraic and calculus equations, and accept additional sets of science and engineering formulas. It is even possible to transfer data and equations between calculators via cables or infrared (IR) transmitters/receivers.

Buy a Cheaper Calculator!!

My view of the situation is this: Very few students who buy a fancy calculator in order to substitute its power for their studying, do very well. Frankly, from what I've seen, most of the built-in solutions are either too general, too specific or just too inconvenient to be useful, and most students find that either they use that big brick like a regular calculator, or they write their own functions, just as you would write out your own formula card. You have to show the work and steps anyway. Why not just learn the Physics?

Ixnay on the TI-92 – It's Not a Calculator (And the TI-89 is gone too.)

The TI-92 machine has been around for a while – it's easy to spot because it has a QWERTY keyboard. Some have found them to be a klutzy difficult calculator, but as the largest "calculator" on the market, they have real geek appeal. While I can appreciate that having something big and powerful is cool, the fact is that the TI-92 became a real pain in Fall 2000. Several students were using its symbolic math routines and it became *painfully* obvious that they could barely do the calculus on their own. Worse, because they don't know what they are doing, they don't get it right using their fancy machine anyway. So I am tired of messing with these things – the TI-92 family and any other so-called calculator with a QWERTY keyboard are OUT. The TI-89, I believe, is the same as the TI-92 without the keyboard. It's OUT, too. Not allowed. End of story. If your ordinary looking graphical calculator does symbolic math, better talk to Dr. Phil. This may include the HP-48 and others – see the next section to learn about more problems.

Algebra and Calculus *versus* The Solver

Solvers and graphical solutions to problems offer interesting checks to your work, but since one of the grading requirements is that you "show your work" on the paper, unless you intend to staple your calculator to each problem, you simply can't get any credit for simply using your Solver function. It is the same thing as "doing the work in my head" – unless you intend to staple your *head* to the paper, you won't get credit for the work. You should also know that these alternate calculator methods do not always work properly. Dr. Phil's suggestion is simple: ***Learn to do the math with pencil and paper.***

MTBF (Mean Time Between Failures)

No, this isn't some sick statistic on awarding F's to students. MTBF is actually a term to describe how often computer equipment breaks down. I have seen many three and four year old calculators get chewed up in PHYS-205 and learning to use a new calculator in the middle of a course can be traumatic. In the mid-70's many of us carried two calculators to exams, just in case one of them tubed out on us. Today's calculators are a lot more reliable than in those "old" days, but there are still plenty of "biodegradable" units that were never built to survive more than a year or two. While I can appreciate that no one wants to spend more money, we do depend a lot on our calculators in a course like this, and having a calculator that has keys that don't work right is just begging for trouble. Do yourself a favor: if you need a new calculator, buy it now, before a change becomes unsettling. At the very least, many older calculators

need new batteries right about now. You'll thank me later. *Dr. Phil just changed the AAA's again in his 1995 HP-48GX in Summer 2002 – one set of batteries seems to last me 2 to 2½ years… not forever.*

"I Understand the Physics, I Just Can't Do The Problems"

This is a refrain that is heard all the time. Yet the truth is that if you can't do the problems, then you probably don't really understand the physics. Physics isn't just equations, however, it is what you do with them. In Modern Physics, the situation can be worse, because your sense of reality will fool you. Often, people who have trouble with doing the problems, also don't have a clue as to what the correct answer should look like. If you *really* understood the physics…

Practice, Practice, Practice

Very few people are so talented that they can leap into any new endeavor and have permanent success without every practicing. Beginner's luck usually doesn't last very long. So you're in a Physics class... what do you do? Well, besides coming to class, reviewing you notes, opening your textbook occasionally, the best advice is to do some Physics problems. Start with the assigned (i.e. recommended) problems. If you have problems, don't just race to the answers in the back of the book, or look for posted solutions, try looking at the worked out examples in the text or from the class and reproduce that work.

PTPBIP (Put The Physics Back Into the Problem)

So you've read the problem, figured out what's given, determined what is being asked for, decided on what equation(s) you need and played plug-'n- chug on your calculator. So you're done, right? Well, how do you know if the answer is right? Well, first off, you can check to see if the answer makes sense. This is what I refer to as "PTPBIP", Putting The Physics Back Into the Problem. It is very important, "real" physicists do it all the time. You needn't write anything extra down, but if you expect that the block should go to the right, then it is very satisfying if your answer also says that the block will go to the right. It may be that the block will go to the left, and that the Physics is trying to tell you something, but rarely will a horizontally moving block travel up. That would be a hint that something funny is going on.

Reality Check Time – Expectations:

Make a mental note of two things: (1) the grade you realistically would like to get in PHYS-309 and (2) the minimum grade that you have to get. If you aren't sure of the latter, now is the time to check with your department. These two grades should represent attainable goals, and given your quiz and exam performance you can plan your study schedule accordingly. Week 13 is not the time to realize that your GPA is too low for you to keep your scholarship.

Overloads:

It's a Y2K4 college fact: You are probably taking too many classes and working too many hours. In a perfect world, the best way to do Physics is to abandon everything else and just do the Physics. Since you probably can't do that, now is the time to figure out what you can cut out of your schedule. Hey, it's only for a few weeks, and believe me, you'll thank me later if you at the very least arrange a few days off before each exam.

Office Hours:

It will take a few days to shake down everyone's schedule and get into a rhythm. Frankly, I don't get enough business during office hours, but boy do I hear the kvetching about how hard Physics is and how awful the Quizzes are. If my office hours are not convenient to your schedule, then it is up to you to make an appointment or swing by the office and see if I'm in. Or call. You've got the number.

Dr. Philip Edward Kaldon - Born western upstate New York; Junior High near New York City; High School in Greensboro, North Carolina (1976). B.A. Integrated Sciences, Northwestern University (1980); M.S. Physics, Michigan Technological University (1986/88); Ph.D. in Applied Physics, Michigan Technological University (1989). Physics Teaching: WMU, KVCC, GVSU, Hope College. Just finished a term as President—Michigan Section of the American Association of Physics Teachers (MIAAPT). After years of working at Western part-time, for 2003-2004, Dr. Phil has a full-time faculty

appointment as an Assistant Professor. Dr. Phil pursues many science and science literacy efforts, and on the first day of class, he is on Day 2199 of writing a massive science fiction romantic epic novel. A fourth readable draft of a complete novel, The Devil's Coffin, set in the same sci-fi universe, is on Day 1019. No – it's not ready for you guys to read yet. Twenty-one short-stories have now been sent off to Sci-Fi writing contests (one Second Place finish, one Finalist in the "big contest", one Laudable Mention in a "little contest") and ten to commercial Sci-Fi magazines (all rejected), so he is closer to getting published! In addition, Dr. Phil has been accepted into the prestigious 2004 Clarion Science Fiction and Fantasy Writers Workshop, an intensive six-week boot camp for SF writing, so no Summer Session I or II teaching this year.

Why We Do All This:

> **science literacy** *n.* An exposure to science in a historical context that serves to allow a person to observe the world around them with understanding, deal with technological applications at home and work, appreciate the distinction between fact and speculation in the media and politics, have a working knowledge of numbers and the scale of the universe, and be able to pursue more information if desired, as a function of everyday life.
>
> Philip Edward Kaldon, Fall 1995

The Disclaimer

This Syllabus has been revamped, rewritten, respellchecked, reeditted, re-etc., more times than I can count for different Physics courses. Occasionally old, out of date material remains from GVSU or WMU or KVCC, for which I apologize. Any references to Physics 270 in any of our handouts, refers to the Modern Physics course which Dr. Phil taught at Hope College. If there are real errors, you will be notified!

We Are Here To
Change The Way You Think
-
There Are No Stupid Questions
(Just Ones That Half The Class Wanted Asked Anyway)
-
UNITS Will Save Your Life
PTPBIP !
(Put The Physics Back Into the Problem!)
-
Physics is Phun
-
(This is the Fun part.
Are we having Fun yet?)

PHYS-309 (3) (Kaldon) < MTu ThF 10:00-10:50am 1110 Rood> Rev. 1/07/2004

Chapter assignments are approximate – actual chapters will depend on our actual pace.

Week	Class Dates	Topic (TZD - 2nd Edition)	Special
1.	6 January	"The Big Picture"	*Quiz 1*
	8,9 January	Review of Classical Physics	Topic 1 Assigned
2.	12,13 January	Ch. 1 - The Space and Time of Relativity	*Quiz 2*
	15,16 January		
3.	**19 January**	**MLK Day Convocation and Activities**	*Quiz 3*
	20 January	Ch. 2 - Relativistic Mechanics	
	22,23 January		
4.	26,27 January	Ch. 3 - Atoms	**Exam 1 (Ch. 1-2) -**
	29 January	Ch. 4 - Quantization of Light	**1/29 Thu.**
	30 Jan.		
5.	2,3 February	Ch. 5 - Quantization of Energy Levels	*Quiz 4*
	5,6 February	Ch. 6 - Matter Waves	
6.	9,10 February	Ch. 7 - The Schrödinger Equation in One Dimension	*Quiz 5*
	12,13 February	Ch. 8 - The Three-Dimensional Schrödinger Equation	
7.	16,17 February	Ch. 9 - Electron Spin	*Quiz 6*
	19,20 February	Ch. 10 - Multielectric Atoms: the Pauli Principle and Periodic Table	
8.	23 February	Ch. 11 - Atomic Transitions and Radiation	**Exam 2 (Ch. 3-8) –**
	24 February		**2/24 Thu.**
	26 February		*Quiz 7*
9.	**27 Feb. - 5 March**	**Spring Break <No Classes All Week>**	
10.	8,9 March	Ch. 12 - Molecules	*Quiz 8*
	11,12 March		
11.	15,16 March	Ch. 13 - Solids – Theory	*Quiz 9*
	18,19 March	Ch. 14 - Solids – Applications	
12.	22,23 March	Ch. 15 - Statistical Mechanics	*Quiz 10*
	25 March	**2004 March Meeting of the American**	Topic 1 due - 3/24 @ 5pm
	26 March	**Physical Society, Montréal QE**	**Exam 3 (Ch. 9-14) -**
		22-26 March 2004	**3/25 Thu.**
13.	29,30 March	Ch. 16 - The Structure of Atomic Nuclei	*Quiz 11*
	1,2 April		
14.	5,6 April	Ch. 17 - Radioactivity and Nuclear Reactions	*Quiz 12*
	8,9 April		
15.	12,13 April	Ch. 18 - Elementary Particles	*All Late Quizzes Due 4/16*
	15,16 April	**PHYS-309 Course Review (1-2 days)**	
16.	**19-23 April**	**FINALS WEEK**	**Final Exam - 4/22 Thu. 10:15am-12:15pm**
17.	*27 April*	*Grades Due on Tuesday at Noon*	